BRIEF REPORT

# THE EFFECTS OF OMT ON PROGRESSIVE MASSIVE FIBROSIS: A BRIEF REPORT OF AN ADJUNCTIVE THERAPY TO IMPROVE RESPIRATORY FUNCTION IN APPALACHIAN COAL MINERS

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Black lung

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Progressive massive fibrosis

Recently in central Appalachia, there has been a resurgence of the more complicated form of black lung disease known as progressive massive fibrosis (PMF). This brief report was aimed at determining the effects osteopathic manipulative treatment (OMT) could have to improve the lives of these individuals. This brief report involved a former Appalachian coal miner diagnosed with PMF. Over the course of a year, the patient was seen and treated with OMT. Though the patient reported improvement in his activities of daily living compared to previous, there was no significant data according to spirometry or quality of life metrics. This study illustrates that OMT has the potential to provide adjunctive treatment for patients with PMF. Limitations due to sample size and socioeconomic deficits of former Appalachian coal miners warrant further study.

## INTRODUCTION

Coal mining has played a significant role in the economy and stability of individuals who call the Appalachian Mountains their home.[1] Unfortunately, there are several work hazards associated with mining, specifically the inflammatory effects that inhaling coal dust causes to the alveoli—ultimately scarring lung tissue.[2] Over time, this damage leads to 1–2 mm inflammatory nodule cells, collagen fibers, and black dust—all of which indicate coal worker's pneumoconiosis (CWP).[2] In some instances, CWP can progress to a more complicated case of black lung known as progressive massive fibrosis (PMF), which is defined as parenchymal lesions ≥ 2 cm, which are most often found in the upper lung fields.[3]

Brandon Crum, DO, a radiologist in Eastern Kentucky, identified 60 cases of PMF in active and former coal workers diagnosed at his practice from January 2015 through August 2016.[4] This sample highlights an unexpected rise in coal workers suffering from PMF as the disease was thought to be essentially eradicated, falling to a prevalence of 0.08%, according to the Coal Worker's Health Surveillance Program (CWHSP) in 1998. Since that time, however, the prevalence of PMF cases has been on a logarithmic rise reaching 3.23% in 2012 and passing 5% in 2015.[5]

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Osteopathic manipulative treatment (OMT) provides a hands-on treatment that has been found to improve the respiratory function in several pulmonary etiologies.[6] In patients who have been hospitalized with pneumonia, various OMT techniques have been found to reduce a patient's length of hospital stay, duration of intravenous antibiotics and incidences of respiratory failure and death when compared to those who received conventional care alone.[7]

This report illustrates the effects of OMT as a possible adjunctive therapy to improve pulmonary function and quality of life in a former Appalachian coal miner diagnosed with PMF.

## PATIENT INFORMATION

### Presentation

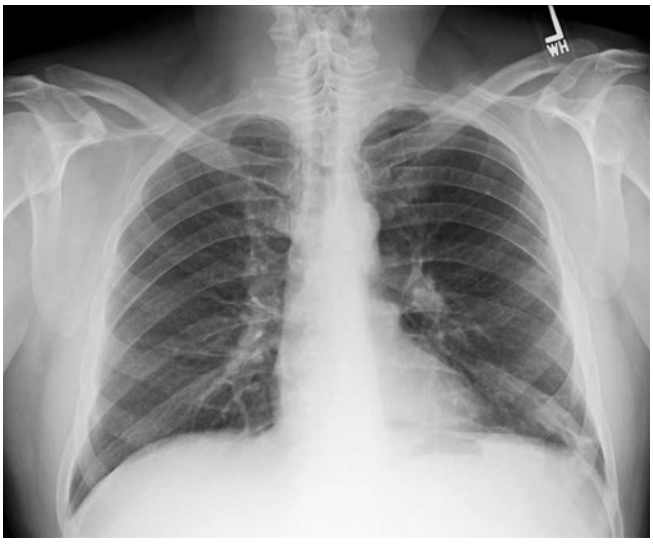
This is a 56-year-old male who worked underground in the Appalachian coal mines for 32.5 years. Despite the fact he has no history of tobacco use and was otherwise a healthy individual, the patient developed significant shortness of breath. He was diagnosed with chronic obstructive pulmonary disease (COPD) at that time and was found to have coal worker's pneumoconiosis. Due to his crippling shortness of breath, the patient was placed on disability on July 30, 2015.

Over the past several years, his symptoms have been chronic, worsened with exertion, and managed with budesonide/formoterol (Symbicort®) twice daily. Prior to the onset of this

study, the patient's most recent chest X-ray classified his black lung disease as category A progressive massive fibrosis, defined as one or more large opacities each >10 mm in diameter with combined dimensions <50 $mm^2$, as seen in Figure 1.[3,8] Upon initial presentation at the onset of the study, the patient reported severe shortness of breath at rest that, in combination with a non-productive cough and exertion, had caused several syncopal events due to inadequate oxygenation.

### FIGURE 1:

This chest X-ray shows the patient's first imaging obtained on August 26, 2016, at the time of PMF diagnosis. Looking at the peripheral lung fields, there are small circular opacities throughout that are consistent with coal worker's pneumoconiosis, while the middle- to upper-lung fields show large circular areas of enhancement consistent with PMF.




## Patient history

Past medical history was notable for diminished sensation of the right lower extremity compared to the left from a mining accident that involved a ruptured calf muscle and right fibular fracture. He has chronic cervical paraspinal tenderness due to a disk herniation at C3/C4; a torn rotator cuff repaired in January 2009, causing chronic right shoulder pain; as well as chronic low back pain, all managed with diclofenac twice daily. He has no allergies, does not drink, use tobacco products or use illicit drugs, and his family history is non-contributory.

## Examination

Exam findings were consistent with a breathing pattern of mixed obstructive/restrictive lung disease showing bilateral inspiratory and expiratory wheezing, commonly seen in PMF cases.[9] The patient was tachypneic, but vitals were otherwise normal. Osteopathic structural examination revealed significant somatic dysfunction, most notably regarding specific suture restriction, upper extremities, ribs, thoracic and cervical regions as seen in Tables 1A and 1B.

### TABLE 1:

These tables denote the structural findings found during each patient visit throughout the study where structural regions pertain to the area of assessment with corresponding diagnosis. Common nomenclature for diagnosing the cervical-lumbar spine denotes a diagnosis in the degree of flexion/extension, side bending/rotation or neutral position based on Fryette's Laws of spinal motion such that a diagnosis of C-6 ERSL indicates that on structural examination, the sixth cervical vertebrae appeared extended, rotated and side bent to the left.[11] Table 1A corresponds to the patient's first 5 treatments with OMT, while Table 1B corresponds to the last 5 treatments with OMT.

*See following page for Tables 1A and 1B.

## TABLE 1A:

Treatment sessions 1–5

| STRUCTURAL REGION | TREATMENT SESSION #1 DIAGNOSIS | TREATMENT SESSION #2 DIAGNOSIS | TREATMENT SESSION #3 DIAGNOSIS | TREATMENT SESSION #4 DIAGNOSIS | TREATMENT SESSION #5 DIAGNOSIS |
|---|---|---|---|---|---|
| **Cranial** | - | Suture restriction at the left and right occipitomastoid<br>Right occipital petrous<br>Right sphenoid squamous | Suture restriction at the left and right occipitomastoid<br>Right occipital petrous<br>Right sphenoid squamous | - | - |
| **Cervical** | C-6 ERSL | OA $ES_RR_L$ | OA $ES_LR_R$<br>C-3 ERSL<br>C-4 ERSL | - | OA $FS_LR_R$<br>C-3 $FSR_L$<br>C-5 $ERS_L$ |
| **Thoracic** | T-1 $ERS_L$<br>T-2 $ERS_L$<br>T-8 $ERS_L$<br>T-9 $NS_LR_R$ | T-1 $FRS_L$ | T-2 $NS_LR_R$<br>T-4 $NS_LR_R$<br>T-6 $NS_RR_L$ | T-2 $NS_LR_R$<br>T-4 $NS_LR_R$ | T-2 $NS_LR_R$<br>T-4 $NS_LR_R$<br>T-10 $ERS_L$ |
| **Lumbar** | L-5 $ERS_L$ | - | - | - | - |
| **Upper Extremity** | Bilateral ulnar deviated laterally<br>Radial head posterior<br>Bilateral distal and proximal carpal tunnel restriction<br>Bilateral interosseous myofascial restriction<br>Left AC joint inferior<br>Right SC joint superior | Right SC superior<br>Right bicep tendon Tightness<br>Restriction at right upper and lateral scapula | - | Right AC joint inferior and right SC superior/ anterior | Right SC superior and right AC inferior<br>Left SC joint inferior<br>Right radial head posterior |
| **Lower Extremity** | - | - | - | Right distal fibula posterior | - |
| **Ribs** | Superior sternal restriction<br>Ribs left 6–10, 3–5 and 1 exhaled | Ribs left 1–2 and 6–10 exhaled<br>Ribs right 6–10 exhaled | | Distal and proximal sternal restriction<br>Ribs left 6–10 exhaled | Bilateral rib 1 exhaled |
| **Innominate/Pelvic/ Sacrum** | - | - | - | Bilateral psoas tightness | - |
| **Diaphragm** | - | - | - | Right restriction | - |
| **Other** | - | - | - | - | Bilateral latissimus dorsi muscle tension |

### TABLE 1B:

Treatment sessions 6–10

| STRUCTURAL REGION | TREATMENT SESSION #6 DIAGNOSIS | TREATMENT SESSION #7 DIAGNOSIS | TREATMENT SESSION #8 DIAGNOSIS | TREATMENT SESSION #9 DIAGNOSIS | TREATMENT SESSION #10 DIAGNOSIS |
|---|---|---|---|---|---|
| **Cranial** | - | Suture restriction at right and left occipital mastoid<br>Right occipital petrous<br>Right Sphenoid squamous<br>Right frontal and right temporal suture | - | Suture restriction at right occipital-mastoid<br>Right sphenoid squamous<br>Left occipital petrous,<br>Right greater wing/ zygoma | Suture restriction showed ligamentous nuchae tightness |
| **Cervical** | OA $FRS_L$<br>C-2 $ERS_L$<br>C-4 ESR | OA $ES_LR_R$ | C-5 $ERS_R$ | OA $ES_RR_L$ | - |
| **Thoracic** | T-2 $NSRR_L$ | T-3 $NS_RR_L$<br>T-4 $NS_RR_L$<br>T-8 $ERS_R$ | T-2 $ERS_L$<br>T-3 $NS_RR_L$<br>T-5 $ERS_L$ | T-1 $ERS_L$<br>T-12 NSLR | T-1 $ERS_L$<br>T-12 NSLR |
| **Lumbar** | - | - | - | L-5 $ERS_L$ | L-4 $FRS_L$ |
| **Upper Extremity** | Left radial head posterior, proximal carpal articular restrictions<br>Left interosseous membrane tightness<br>Left SC joint inferior<br>Left AC joint inferior<br>Right AC joint superior<br>Right SC joint superior<br>Right Triceps tightness | Left radial head anterior<br>Right radial head posterior<br>Right AC joint inferior<br>Right SC joint superior<br>Right glenohumeral joint | Right SC superior | Left SC anterior<br>Right AC inferior | Right subscapularis tightness and scapular dyskinesia<br>Right glenohumeral myofascial restrictions<br>Pectoral muscle tightness bilaterally |
| **Lower Extremity** | - | - | - | - | - |
| **Ribs** | Ribs left 1–3 and 6–9 exhaled<br>Right 6–9 ribs exhaled<br>Sternal restriction to forward and superior glide | - | Ribs left 2–7 exhaled<br>Sternal restriction | Ribs left 1–4 exhaled<br>Sternal restriction | Ribs right 1–6 exhaled<br>Sternal restriction |
| **Innominate/ Pelvic/Sacrum** | - | - | - | Sacrum showed right on right torsion<br>Innominate showed right anterior rotation | - |
| **Diaphragm** | Diaphragm bilateral restriction | - | - | - | - |
| **Other** | - | - | - | Abdomen showed line alba restriction<br>Bilateral latissimus dorsi and trapezius tightness | - |

### Diagnosis and treatment

The patient was treated using a multitude of techniques throughout this study. The most common techniques that provided resolution of somatic dysfunction included muscle energy, balanced ligamentous technique and functional. Other techniques that were implemented included both indirect and direct myofascial release, as well as craniosacral treatment of his suture restrictions. Most notably, ribs 6–10 were commonly found to be in exhaled dysfunction and the patient often had improved respiratory mechanics after treating this dysfunction using the muscle energy treatment as seen in Figure 2.

FIGURE 2:

This image denotes the proper position and steps used in treating exhaled ribs that are restricted in inhalation in the bucket handle family of ribs. Bucket handle ribs denote ribs that predominantly move about an anterior-posterior axis.[11] This technique was performed by the teaching faculty at the University of Pikeville – Kentucky College of Osteopathic Medicine.[15]

## RESULTS

The patient was treated at a total of 10 visits over the course of 1 year; however, we only compared data from the last 5 visits where the patient was treated on the most consistent schedule, receiving OMT approximately every 2 weeks in accordance with the original research protocol. As seen in Table 2, looking at pulmonary function testing, there was no statistically significant data from treatment number 6 compared to the conclusion of the study, treatment number 10. The 36-Item Short Form Health Survey (SF-36)[10] was graphed over time, as seen in Figure 3. Physical functioning and general health both showed gradual improvements in score over time while most categories stayed relatively constant throughout the study. The patient's most recent chest X-ray as seen in Figure 4 shows no significant reduction in opacity size, and in fact may indicate worsening of his fibrosis when compared to Figure 1.

TABLE 2:

The data represents spirometry findings during which the patient was treated on the most consistent basis, 5 treatment sessions between 6/14/2018–9/20/2018 (sessions 6–10) where a p-value <0.05 represented statistically significant data. Total duration of treatment occurred from 8/29/2017–9/20/2018.

| FEV/ PREDICTED (%) | PRE-TREATMENT | POST-TREATMENT | T-TEST |
|---|---|---|---|
| **Treatment #6** | 67 | 67 | Not able to be determined |
| **Treatment #10** | 66 | 66 | |
| **FVC (L)** | **PRE-TREATMENT** | **POST-TREATMENT** | |
| **Treatment #6** | 3.88 | 3.82 | 0.301 |
| **Treatment #10** | 3.63 | 3.86 | |
| **FEV1 (L)** | **PRE-TREATMENT** | **POST-TREATMENT** | |
| **Treatment #6** | 2.54 | 2.62 | 0.371 |
| **Treatment #10** | 2.56 | 2.57 | |
| **FEV1/FVC** | **PRE-TREATMENT** | **POST-TREATMENT** | |
| **Treatment #6** | 0.679 | 0.686 | 0.445 |
| **Treatment #10** | 0.706 | 0.667 | |

FIGURE 3:

This data represents the 36-Item Short Form Health Survey, developed by Rand Health. It is a set of questions pertaining to genetic, coherent and easy-to-administer quality of life measures.[10] It has been shown as a successful quality of life instrument correlating OMT with patients with deep infiltrating endometriosis with colorectal involvement and was adopted for this study.[16] Scores varied from 0–100 with a higher score indicating more improvement in that category while months correlated to the time during which treatments 6–10 were conducted.

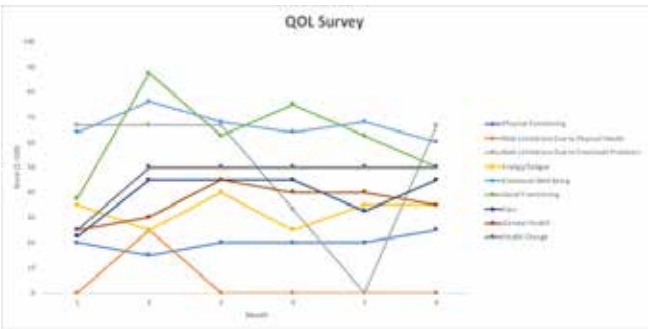
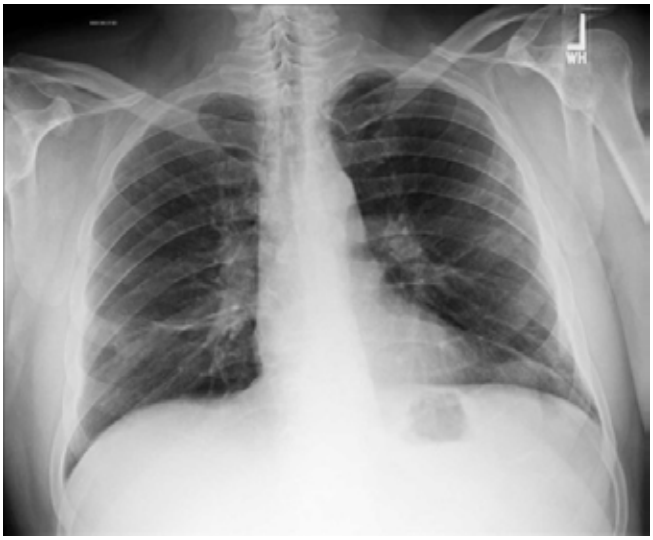


FIGURE 4:
This imaging denotes the patient's most recent X-ray obtained in 2019. Compared to his X-ray from his initial diagnosis of PMF, there appears to be increased evidence of interstitial markings, perihilar adenopathy and enlargement of previous opacities.



## DISCUSSION

Although we were unable to obtain statistically significant data, we were able to observe the subjective effects of OMT on the patient's quality of life. The patient reported throughout the study that he was able to participate in more activities, such as refereeing his grandchildren's soccer games and doing more chores at home. He reported feeling overall less fatigued and tachypneic from the first treatment session to the last treatment session. Incidentally, he was able to decrease the number of anti-hypertensives he was taking from 3 to 2 and, according to his continuous positive airway pressure settings, decrease his average apnea-hypopnea index from 3.3 to 2.9 over the course of 6 months.

The patient's SF-36 survey scores showed variability between visits but showed an overall increase in general health and physical functioning from start to conclusion of the study.[10] These metrics are consistent with the patient's reported increase in activities of daily living as above. His spirometry values also showed variability throughout the study, but always seemed to be acutely improved at each visit when comparing the pre-treatment and post-treatment data. This provides the possibility that OMT can have an adjunctive role in treating patients with PMF, as well as other chronic lung diseases. The patient's chest X-rays obtained from the United Medical Group in Pikeville, Kentucky, show the continued progression of black lung disease, despite osteopathic intervention. OMT has been shown to improve pulmonary function in cases of pneumonia by improving the elasticity of the ribcage and easing muscle tension related to respiratory fatigue.[7,11] However, there is no evidence to suggest OMT can reverse the fibrotic lung scarring associated with PMF, which is further evident when noting the increased interstitial markings between Figure 1 and Figure 4.

The patient was commonly found to have upper extremity, thoracic and rib pathology during almost every structural screening. The thoracic dysfunction likely represents a viscerosomatic reflex, an afferent input from a visceral organ that has an efferent output on a somatic structure in the body such as muscle attachments to bone.[11] The viscerosomatic reflex for the lungs is commonly identified as T2–T7, and this patient was commonly found to have segmental dysfunction within this region.[11] The rib dysfunction likely represents the impairment in the respiratory system and movement of air seen in mixed obstructive-restrictive lung disease. The upper extremity dysfunction may deal with how certain secondary muscles of respiration and bony attachments have origins and insertions involving the distal extremities.[11] One common finding was clavicular dysfunction—both at the acromioclavicular and sternoclavicular joints on the right. The clavicle serves as the major connection between upper appendicular skeleton and axial skeleton by acting as a strut between the scapula and the sternum.[11] While this patient has a history of chronic right shoulder pain, his PMF likely caused restricted movement at the clavicle that propagated to affect the movement of his shoulder concomitantly.

Several limitations effected this study, most notably was the limited sample size. According to the Center for Public Integrity, for more than 40 years, John Hopkins University has had the most sought-after readers of chest X-rays on behalf of coal companies seeking to defeat miners' claims.[12] One of the most sought out readers is Paul Wheeler, MD, who—in more than 1500 cases since 2000, in which he read at least one X-ray—had never found a diagnosis of PMF. However, other readers reviewing the same X-rays found PMF in more than 390 of these cases.[12] While judges have been aware of the inconsistencies from Dr. Wheeler and his colleagues, they are required in these hearings to identify a logical flaw or some other reason not to give his explanation greater weight than other doctors, a difficult task based on Dr. Wheeler's established credibility and the alternative explanations he finds.[12] As a result, about 85% of miners' claims against their former employers have been denied at the initial level.[12]

It is no surprise, then, that miners would be reluctant to participate in a research study that may affect their current litigations with coal companies as they already face an uphill battle to have their claims approved. The fact that so few of these claims are accepted, in an aging health burden demographic further leads to impoverishment in the Appalachian region. In central Appalachia, every county reported poverty rates greater than 20% for the period of 2007–11 compared to a national average of 14.3%.[13] Additionally, in 2011, the Appalachian Region Commission reported that central Appalachia received 31% less in federal expenditures per capita, compared to the national average.[14] With so many obstacles to overcome and an already low socioeconomic status, it is no surprise that miners would not partake in a research study as they are forced to focus on the day-to-day needs of their family.

Osteopathic manipulative treatment may provide a cost-effective adjunctive treatment to improve the lives of Appalachian

coal miners. However, until the socioeconomic deficits of the Appalachian region begin to improve, recruitment into studies such as this will continue to remain difficult. Innovative approaches to provide socioeconomic stability to the central Appalachian region warrants further study and would likely improve patient willingness to partake in clinical research.

## CONCLUSION

Progressive massive fibrosis may continue to increase in prevalence in coal miners in the Appalachian region. This report demonstrates that osteopathic manipulative treatment may provide a non-invasive, cost-effective treatment, that although cannot reverse the chronic changes of black lung disease, may improve quality of life. However, the current legal battles and economic burden that coal miners face may hinder their ability to receive additional treatment.

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